CONJECTURES

ON THE

CAUSE OF THUNDER.

Ut potero explicabo : nec tamen ut Pythius Apollo, certa ut ſint & fixa quæ dixero : ſed ut homunculus, probabilia conjecturâ ſequens. Cic. Tuſc. Quæſt. L. 1. C. 9.

PARIS

M. DCC. LVI.

CONJECTURES

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§ 1. THE air is a body originally electric, & while dry is not a conductor of the electrical fire, it does not receive it from other bodies, nor does it communicate it to them; otherwiſe no body ſurrounded by the air, could be electrified poſitively & negatively, for if we ſhould try to electrify it poſitively, the air would immediately carry off the *ſuperplus*, or if it was negatively, the air would ſupply what was wanting (*a*).

2. The electrical fire is equally diffu-

(*a*) Experiments on Electricity. French Tranſlation, *pag.* 92.

ſed through our walls, our apartments; the earth & all the common maſs of matter, thus the glaſs globe turning while it rubs againſt the cusheon, draws the fire from the cusheon, which is ſupplied by the frame of the machine, & the frame by the floor upon which it is placed. *Cut off the communication by means of a thick piece of glaſs, or a cake of roſin placed below the cusheon, no more fire can be produced* (*a*).

3. This experiment proves evidently the above remark, that the air is a body originally electric, that it neither communicates the electrical fire to other bodies, nor receives it from them: and if it ſometimes happens that the air conducts electricity, it is only when it is moiſt or charged with non-electric vapours.

4. We ſuppoſe the conſtituent particles of that element to be ſpherical, and in their interſtices the matter raiſed in ex-

(*a*) Experiments on Electricity. French Tranſlation, p. 96.

halations to be diſperſed. Theſe exhalations proceed from the mineral, vegetable & animal bodies, which abound over all the ſurface of the earth.

5. But of all the exhalations, that of water is the moſt copious: not to mention the inſenſible perſpiration of organized bodies, in the compoſition of which that element makes a very conſiderable part; the fountains, the rivers, the lakes, &c. with which the whole ſurface of the earth is as it were furrowed, and the ſea (which is indeed the ſource of all) furniſh a great quantity of watery vapours. Water is the vehicle of many other exhalations, and one of the beſt conductors of the electrical fluid that we have, in ſo much that a volume of it can be ſubſtituted in place of the metallic conductor, in our common experiments.

6. In the great heats of ſummer, the watery vapours are raiſed in great abundance, as are alſo the other exhalations from mineral, vegetable & animal bo-

dies, and of which a great part is non-electric.

The water thus raiſed is by the influence of the ſun extremely rariſied and attenuated, perhaps even nearly reduced to its original elements, as are likewiſe the other exhalations of different kinds.

7. Theſe great heats ſo proper for the raiſing of vapours, ſerve not only to rarify the air, whence neceſſarily proceeds a friction between the conſtituent particles of that element & the matter furnished by exhalations, but likewiſe to aſſiſt the inteſtin motion of that matter, which, as it conſiſts of heterogeneous bodies, is ready to undergo a fermentation, and of conſequence, a conſiderable degree of friction amongſt its conſtituent particles.

8. The friction then of the air-globules againſt the non-electric particles raiſed in exhalations, and diſperſed through ^their^ interſtices, ~~their~~ together with the motion, fermentation and friction of the non-electric particles againſt

one another, and of conſequence, againſt the air-globules, is ſufficient for producing a very conſiderable degree of electricity in the atmoſphere, the air-globules being conceived to act as little glaſs-globes, in drawing the electrical fire from the non-electric matter, and communicating it to the particles of water always ready to receive it, while the other non-electric particles do the office of little cusheons.

But it is only in ſuch places of the atmoſphere where there happens to be a proper mixture of the watery particles with the air-globules & the non-electric matter, that ſuch electricity can be excited, or at leaſt it is only from ſuch portions of the atmoſphere, that electrified clouds can be formed.

9. For, in ſuppoſing too great a quantity of the watery particles, the air-globules muſt be ſo drowned, as to render it abſolutely impoſſible for them, to draw the electrical fire from the non-electric matter diſperſed throngh their in-

terſtices, as in our common experiments, by which we ſee that the glaſs-globe when wet or in contact with water or moiſt vapours in too great a ſurface, is incapable of pumping the electrical fire from the contiguous bodies.

10. In ſuppoſing, on the contrary, too few or none of the watery particles, ſuch portions of the atmoſphere, whatever quantity of electricity may be there excited, muſt be incapable of furniſhing thunder-clouds, as it is only the watery particles that are capable of uniting themſelves, & coaleſcing into one denſe body, ſo as to form clouds: thus all the electricity that we can ſuppoſe to be excited in ſuch circumſtances, muſt be diſperſed and diſſipated without producing any conſiderable effects.

11. Beſides, in thoſe places of the atmoſphere, where all or moſt of the exhalations happen to be of the electric kind (which however ſeems rarely to happen) little or no electricity can be excited.

12. In thoſe portions of the atmoſphere, where the water raiſed in vapours, being by the heat of the ſun extremely rarified, ſubtilized and attenuated, does not preſent it's particles to the air-globules, in ſo many or ſo large ſurfaces as to obſtruct or hinder the production of electricity, theſe watery particles, by the cauſes abovementioned, become ſtrongly electrified.

13. The watery particles thus electrified, acquire a repulſive force, recede from one another, are ſtill further rarified and raiſed higher in the atmoſphere; thus their electricity is diſperſed and divided into an innumerable quantity of what we may call atomical points.

The non electric matter from whence theſe watery particles have received their fire, falls inſenſibly to the ground, while they, now ſurrounded by dry air on all ſides, ſtrongly retain their electricity.

14. In this ſtate the watery particles

continue, untill by the winds, cold or other circumſtances, they are condenſed, and form thick clouds.

15. Theſe clouds are ſtrongly electrified, & that fire, which before the condenſation of the ſmall electrified particles which conſtitute them, was diſperſed through ſo great a ſpace of the atmoſphere, as ſcarcely to be ſenſible, & which, in that ſtate, was incapable of producing any remarkable effect, being now united into one body, becomes one of the moſt powerful agents in nature.

16. Clouds electrified in this manner, meeting with others not electrified, tops of mountains, ſteeples, houſes, &c. give a violent ſhock to theſe bodies, in communicating to them their *ſuperplus* of electrical fire.

In this manner might the electricity of all thunder-clouds be accounted for, were they all poſitively electrified.

17. But the incomparable Mr. FRANKLIN has, by late experiments, diſcovered, that *thunder-clouds are for the moſt*

part negatively electrified, that is, *have leſs than their natural quantity of electrical fire*, hence, that moſt frequently, when it thunders, *it is the earth that ſtrikes the clouds, & not the clouds that give a ſhock to the earth.* This is without doubt one of the moſt beautiful diſcoveries that our age can boaſt of.

18. The ingenious obſerver erected upon the top of his houſe a rod of iron, to receive the electricity from the clouds. Two ſmall bells were placed in ſuch a manner, as to let him know when this rod was electrified (*a*).

Having charged two bottles, the one by the celeſtial fire, the other by the excited glaſs-globe, & ſuſpended between the two by a ſilk thread, a ſmall ball of cork, he found that the ball played with rapidity betwixt the two, & continued ſo to do, untill both the bottles were

(*a*) Mr. Franklins Letters tranſlated into French by M. Maty. Journal Œconomique pour le mois d'Octobre 1754. p. 153. & Extract of theſe Letters by the ſame, Journal Britannique, p. 239.

equal: this proves that they were differently charged; and as that by the machine was charged positively, the other must necessarily have been charged negatively. This experiment was repeated several times, with the same success (*a*).

By presenting to the rod electrified by lightening, several bottles electrified in the ordinary way by the hooked wire, he found that the chime stopped, because the bottles gave to the rod what the thunder-cloud took from it (*b*).

It remains then that we endeavour to account in a rational manner for the negative electricity of clouds, which, by a little attention to what happens in our atmosphere, we may, perhaps, attain to.

19. There is without doubt dispersed through the atmosphere, at certain

(*a*) Journal Œconomique, p. 154. Journal Britannique, pag. 240. & 241.

(*b*) Journal Œconomique, pag. 155. & 156. Journal Britannique, p. 241.

times, & eſpecially in the heats of ſummer, a great quantity of ſulphureous vapours, proceeding from the exhalations of mineral ſubſtances, which abound over all the ſurface of the earth.

Though theſe exhalations afford great abundance of ſulphureous matter, yet there ſeems to be another ſource, hitherto unattended to, from whence a very ſubtile, aërial ſulphur may be formed.

20. There appears to be every where diſſeminated through the atmoſphere, a certain quantity of the ſulphureous or vitriolic acid, which is the *acidum vagum* of the great NEWTON, and is probably no more than a certain modification of the ſubſtance of light. Of all the experiments that tend to demonſtrate the exiſtence of this acid in the air, the moſt convincing is that of dipping linnen rags in a ſolution of the pureſt fixt alcaline ſalt, and expoſing them for ſome time to the air, ſo as they may be sheltered from the rain; by which ſimple proceſs,

the alcaline ſalt is changed into vitriolated tartar, which is a neutral ſalt formed by the combination of the ſulphureous acid with the fixt alcali, which could never happen from any other cauſe than the ſulphureous acid contained in the air, and readily attracted by the alcaline ſalt.

21. Other experiments demonſtrate that the ſame acid united with an inflammable matter of any kind, whether of the mineral, vegetable or animal kingdom, forms true ſulphur.

There is without doubt, in the atmoſphere, a great quantity of inflammable matter, proceeding from the exhalations of mineral, vegetable and animal bodies.

I conceive that the ſulphureous acid diſſeminated through the whole atmoſphere, meeting with this inflammable matter, by the aſſiſtance of the heat of the ſun, in the ſummer ſeaſon, and the ſmalneſs of the particles into which itſelf as well as the inflammable matter is reduced, unites itſelf with it, and

thus forms extremely ſubtile ſulphureous particles.

22. Mr. FRANKLINS experiments ſhow, that there is a real difference between reſinous and vitrous electricity, as the late ingenious Mr. DU FAY of the Royal Academy of Sciences had formerly remarked.

Though Mr. FRANKLIN owns that he has not pushed his experiments ſo far as he could have wiſhed, yet it appears pretty evidently from them, that *as the glaſs-globe charges poſitively, ſo the ſulphur one charges negatively*, or in other words, that *the glaſs globe throws off the electrical fire, & the ſulphur one drinks it in* (*a*).

23. Since then ſulphur electrifies negatively, it follows, that the ſulphureous particles, in ſuch portions of the atmoſphere as contain a great quantity of them, being ſet into motion by whatſoever cauſe it may be, muſt electrify negatively or *minus* the watery particles

(*a*) Letters on Electricity, Part. 2. p. 104.

which may happen to be diſperſed amongſt them.

Several cauſes may concur to ſet the ſulphureous particles in motion. For, I conceive, that in the firſt formation of theſe particles, the ſulphureous acid, in uniting itſelf to the inflammable matter, raiſes a violent motion & effervescence, that this motion is kept up by the heat of the ſun, a very powerful cauſe, & which might of itſelf be ſufficient to excite a friction amongſt the ſulphureous particles, that this motion, however, is ſtill further increaſed by the fermentation of theſe particles with the heterogeneous matter raiſed in exhalations and diſperſed through the atmoſphere, and by the inteſtin motion which this heterogeneous matter muſt, as we obſerved above, neceſſarily undergo.

Beſides, we learn from an experiment of the ingenious Doctor HALES, that when a pure air & a ſulphureous one meet one another, there ariſes a violent effervescence between the two, by which

which a quantity of elaſtic air nearly equal to that of the ſulphureous air, is abſorbed & deſtroyed (*a*). Since the ſame thing muſt happen in the atmoſphere, wherever there is ſulphureous matter, whether it proceed from mineral exhalations, or whether it may have been formed in the atmoſphere by the union of the aërial acid with inflammable matter, in ſuch places of the atmoſphere, the watery particles diſperſed through the interſtices of the ſulphureous ones, muſt be deprived of their natural quantity of electrical fire, not only by the friction excited amongſt the ſulphureous particles by that efferveſcence, but likewiſe by the deſtruction of the elaſtic air-particles; for, from hence it

(*a*) Statical Eſſays app. Exp. 3. p. 280. & conſiderations on the cauſes of earthquakes. Phil. Tranſ. N°. 497.

In the ſummer we frequently feel a diſagreable, ſuffocating heat in the air, accompanied with an evidently ſulphureous ſmell, occaſioned, probably, by the efferveſcence that happens in the formation of the ſulphureous particles, as well as by the abſorption of a certain quantity of elaſtic air.

muſt happen, that the ſulphureous corpuſcles ~~muſt~~ Will act at full liberty, in negatively electrifying the watery particles, ſince there are few or no air-particles remaining, which other wiſe might, perhaps, have in ſome meaſure counterbalanced the negative electricity produced by the ſulphureous particles.

Hence, from the violent motion & friction of which theſe laſt mentioned particles are ſuſceptible, we may eaſily conceive, that they muſt act with greater force in electrifying negatively, than the air-globules are capable of in electrifying poſitively, even in thoſe parts of the atmoſphere where they are not mixt with ſulphureous vapours, & may act at full liberty.

24. No ſooner are the watery particles negatively electrified, than they repell & recede from one another, are raiſed higher, & detached from the ſulphureous particles. Theſe (together with ſuch non-electric bodies as may be mixt with them, & which as well as the wa-

tery particles muſt be negatively electrified) are diſperſed by the winds, or fall inſenſibly to the ground, without producing any remarkable effect, as they conſiſt of ſmall diſſeminated corpuſcles, which cannot unite themſelves ſo as to form clouds, as the watery particles do (*a*)

25. Theſe watery particles being con-

(*a*) It is probable, however, that the watery particles carry along with them ſome of the moſt ſubtile of the ſulphureous ones, which may contribute ſome what in cauſing that ſtrong ſmell of ſulphur, which ariſes after the clap, in places ſtruck by lightening. From this ſmell, inflamed ſulphureous vapours were imagined to be the immediate cauſe of thunder, thus Lucretius.

Quali naturâ prædita conſtant
Fulmina, declarant ictus, & inuſta vapore
Signa, notæque graves halantes ſulphuris Auras.
L. 6. lin. 218.

But it is certain, that by far the greateſt part of the compoſition of thunder-clouds is nothing but electrified water, & the ſulphureous ſmell ſeems moſtly to proceed from the electrical matter itſelf, for the ſame ſmell diffuſes itſelf very remarkably in apartments where common electrical experiments are performed.

denſed by the cold or other cauſes, form clouds negatively electrified

When a cloud electrified in this manner happens to approach the earth, within the diſtance of the shock, or to meet with others which have their natural quantity of electrical fire, there rushes out from the earth, from theſe clouds or from ſuch other bodies as it may meet, a current of electrical fluid in proportion to the extent of the cloud, with a rapidity & violence as great as if it came from the cloud itſelf. It is the shock of this electrical fire rushing impetuouſly from the earth, that cauſes moſt of thoſe diſaſters ſo well known even in our northern climates.

A negatively electrified cloud, after it has received from the earth, as much electrical fire as it wants, having ſtruck others which have not been impregnated with their due quantity, receives a ſecond time from the earth, or from other clouds, as much as it has communicated to the others, whilſt theſe ſtrike other

clouds, & receive whether from the firſt cloud, or from ſome other, or from the earth, a quantity equal to that which they have parted with; and ſo on, untill all the clouds that are within the reach of the ſhock, have acquired nearly their natural quantity of electrical matter, or fall to the ground in drops of rain. From hence come thoſe repeated claps, of thunder & flashes of lightening, which we commonly obſerve when it thunders (*a*).

26. It appears then, that there may be two cauſes productive of thunder-clouds, 1. The particles of water raiſed in exhalations poſitively electrified by the air, 2. Theſe ſame particles negatively electrified by the ſulphureous vapours which abound in many places of the atmoſphere; and by giving a little attention to the forgoing theory, ſeveral queſtions may be ſolved, for example.

(*a*) Mr. Franklins Letters, in the Journal Œconomique above cited, p. 160.

Why a certain degree of electricity is ſo frequently obſerved in the atmoſphere, without either lightening or Thunder (*a*)?

Why thunder is more common in warm climates, and in warm, dry ſeaſons, or after them, than in cold climates, or cold, moiſt ſeaſons?

Why negatively electrified clouds are ſo frequent?

As I have not had leiſure to make ſo many electrical experiments as I could have wished, by which, the above conceptions might, perhaps, be in ſome meaſure verified, and as I am at the ſame time ſenſible how precarious all theories are, which do not eaſily admit of ocular demonſtration, I have not judged proper to give my thoughts under any other title than merely that of Conjectures. It is not my deſign to eſtabliſh a

(*a*) See Mr. Franklins letters. Journal Œconomique above cited. p. 153, and obſervations on the Electricity of the atmoſphere by the Abbé Mazeas. Phil. Tranſ. Vol. XLVIII for 1753. Part. I. p. 377.

ſyſteme, but to excite others, who have more time and abilities than I, to apply themſelves with diligence to ſuch reſearches.

. . . . . *Fungar vice cotis acutum*
Reddere quæ ferrum valet, exſors ipſa ſecandi.

FINIS.